
	<b>NASA Engineering and Safety Center Technical Assessment Report</b>	Document #: <b>RP-05-109</b>	Version: <b>1.0</b>
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# **Peer Review of the LH<sub>2</sub> Vent Line Test Instrumentation Technical Consultation Report**

**September 22, 2005**

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## **Volume I: Technical Consultation Report**

### **1.0 Authorization and Notification**

The request to conduct a real-time consultation was submitted to the NASA Engineering and Safety Center (NESC) on May 11, 2005.

NESC participation in the peer review of the External Tank Liquid Hydrogen (LH<sub>2</sub>) vent line instrumentation took place on May 20, 2005.

A final report was presented to the NESC Review Board and approved on September 22, 2005.

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## 2.0 Signature Page


### Consultation Team Members

\_\_\_\_\_  
Timmy R. Wilson, NESC Chief Engineer, Lead

\_\_\_\_\_  
Bob Buehrle, GRC


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Bryan Fraser, GRC

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William Kilgore, LaRC

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### **3.0 Team Members, Ex Officio Members, and Consultants**

Timmy R. Wilson, NESC Chief Engineer (NCE)  
 Bob Buehrle, GRC  
 Bryan Fraser, GRC  
 William Kilgore, LaRC


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## 4.0 Executive Summary

The NESC was requested to participate in a peer review of the proposed External Tank (ET) Liquid Hydrogen (LH<sub>2</sub>) tank vent line instrumentation. This device was a custom-designed pitot tube and temperature probe built into a 1-inch flange and installed on the LH<sub>2</sub> vent at the interface between the 4-foot flex hose and vent quick disconnect (QD) during the STS-114 tanking test. The device was intended to determine, by measuring flow in the 8-inch vent line, whether or not the ET vent valve was grossly leaking under cryogenic conditions.


The instrumentation consisted of a pitot-type pressure sensor and a temperature probe mounted in a 1-inch spool piece. These were installed in the Ground Support Equipment (GSE) vent line downstream of the ET vent valve. Static and dynamic pressures sensed at the pitot tube ports were measured with transducers installed in a housing mounted on the ET vent line access arm.

Data was recorded and routed to the control room for real-time monitoring. An attempt was made to validate the KSC design with a flow test conducted at the KSC Launch Equipment Test Facility (LETf).

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## 5.0 Consultation

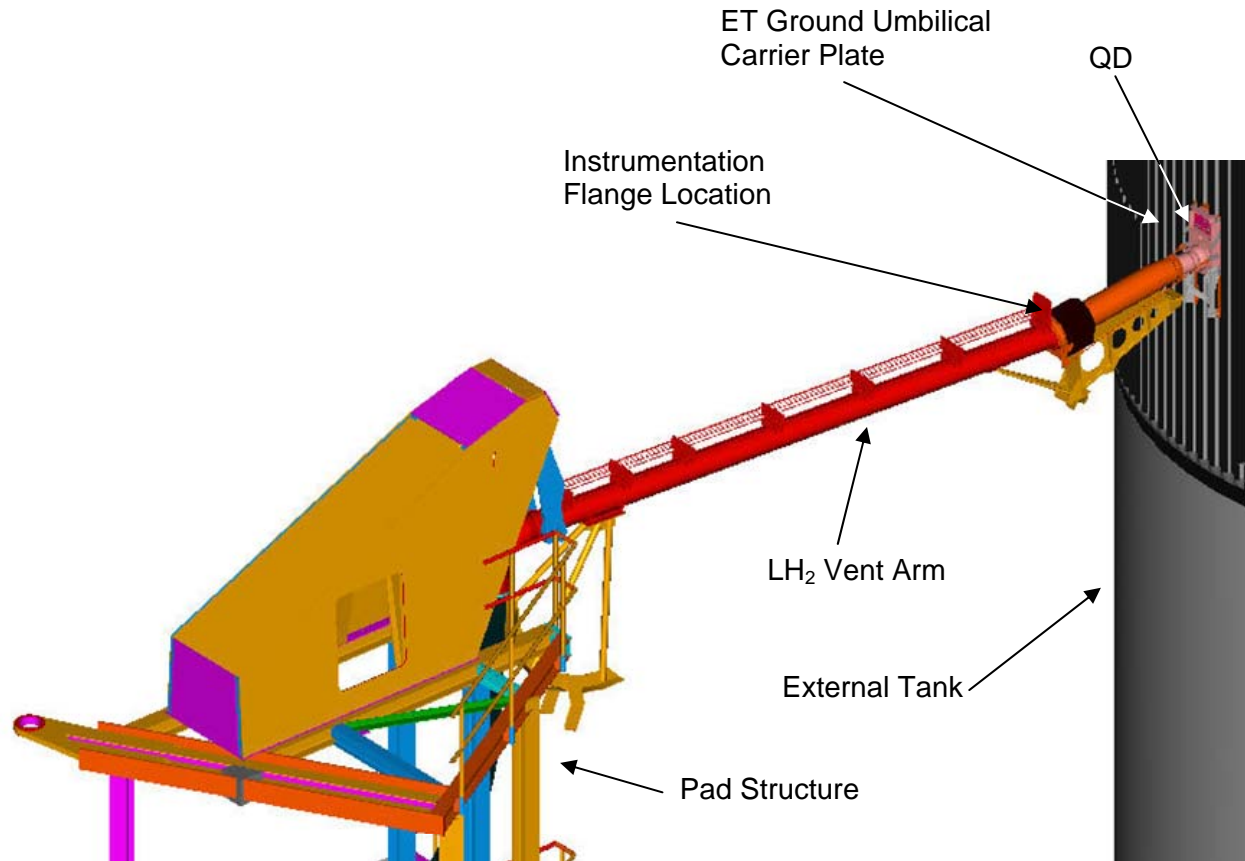
The scope of this consultation was limited to examining and peer reviewing the LH<sub>2</sub> vent line tanking test instrumentation. This consultation was considered a quick turnaround peer review and, therefore, no consultation plan was generated prior to this review.

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## 6.0 Description of the Problem, Proposed Solutions, and Risk Assessment


This device was a custom-designed pitot tube and temperature probe built into a 1-inch flange that was installed on the LH<sub>2</sub> vent at the interface between the 4-foot flex hose and vent quick disconnect (QD).

The device was intended to determine, by measuring flow in the 8-inch vent line, whether or not the ET vent valve was grossly leaking under cryogenic conditions. Refer to Figures 6.0-1 through 6.0-3.



**Figure 6.0-1. External Tank Vent Line Umbilical**




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**Figure 6.0-2. Vent Line Instrumentation Flange**




**Figure 6.0-3 Pitot Tube**

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## 7.0 Data Analysis

The NESC team participated in the review of the instrumentation design and implementation plan, and examined data collected during Launch Equipment Test Facility (LETf) validation of the device. Refer to Section 8.0, Findings, Observations, and Recommendations.

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## 8.0 Findings, Observations and Recommendations


### 8.1 Findings

The team made real-time inputs during the review process. No safety issues with the device were identified, and the team had no objection to installation or employment of the hardware during the tanking test. Due to a number of factors which compromised the calibration (refer to Observations), the instrumentation could be expected to provide only a qualitative “flow/no-flow” indication with a detection threshold of about 300 Standard Cubic Feet per Minute (SCFM), and the Project was cautioned not to rely upon it for a quantitative measure of leakage from the valve. The device did work as expected during the tanking test and generated data sufficient for the Project to conclude the ET vent valve was not grossly leaking.

### 8.2 Observations

The NESC team offered the following observations during the review process.

- O-1. Location of the spool piece in the vent line was not ideal. Measurements were affected by turbulence generated by bellows in the upstream flex line.
- O-2. Helium was used for the validation test, not a mixture of helium and hydrogen as expected in service. *Effect of the gas mixture on the measurement was unknown.*
- O-3. Validation testing was conducted at ambient temperature, not at the cryogenic temperatures expected. *Effect of temperature on the data was unknown.*
- O-4. The test assembly was mounted in a different orientation than the unit installed in the field. *Effect of probe orientation was expected to be minimal, but was an unknown.*
- O-5. Bending of the probe due to mechanical loading in service was unlikely, but the Project was cautioned that if it occurred it would re-orient the probe tip with respect to the flow stream. *This would have an unknown effect on the measurements being taken.*


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## 9.0 Lessons Learned

Given the amount of time available prior to the actual STS-114 tanking test (May 11 to May 17, 2005), NESC participation was limited to assembly of a knowledgeable team with experience using similar instrumentation and participation in real-time discussions. Telecons were held and a plan was implemented to install the device within a couple of days to support the ET test. No significant lessons-learned were generated.


## 10.0 Definition of Terms

Corrective Actions	Changes to design processes, work instructions, workmanship practices, training, inspections, tests, procedures, specifications, drawings, tools, equipment, facilities, resources, or material that result in preventing, minimizing, or limiting the potential for recurrence of a problem.
Finding	A conclusion based on facts established during the assessment/inspection by the investigating authority.
Lessons Learned	Knowledge or understanding gained by experience. The experience may be positive, as in a successful test or mission, or negative, as in a mishap or failure. A lesson must be significant in that it has real or assumed impact on operations; valid in that it is factually and technically correct; and applicable in that it identifies a specific design, process, or decision that reduces or limits the potential for failures and mishaps, or reinforces a positive result.
Observation	A factor, event, or circumstance identified during the assessment/inspection that did not contribute to the problem, but if left uncorrected has the potential to cause a mishap, injury, or increase the severity should a mishap occur.
Problem	The subject of the technical assessment/inspection.
Requirement	An action developed by the assessment/inspection team to correct the cause or a deficiency identified during the investigation. The requirements will be used in the preparation of the corrective action plan.
Root Cause	Along a chain of events leading to a mishap or close call, the first causal action or failure to act that could have been controlled systemically either by policy/practice/procedure or individual adherence to policy/practice/procedure.

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## 11.0 Minority Report (Dissenting Opinions)

There were no dissenting opinions during this consultation.


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## Volume II: Appendices

A      ITA/I Request Form (NESC-PR-003-FM-01)


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## Appendix A. ITA/I Request Form (NESC-PR-003-FM-01)


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<b>NASA Engineering and Safety Center Request Form</b>		
Submit this ITA/I Request, with associated artifacts attached, to: <a href="mailto:nrbexecsec@nasa.gov">nrbexecsec@nasa.gov</a> , or to NRB Executive Secretary, M/S 105, NASA Langley Research Center, Hampton, VA 23681		
<b>Section 1: NESC Review Board (NRB) Executive Secretary Record of Receipt</b>		
Received (mm/dd/yyyy h:mm am/pm) 5/13/2005 12:00 AM	Status: New	Reference #: 05-028-E
Initiator Name:	E-mail:	Center: EXTERNAL
Phone: (202)-314-6341, Ext _____	Mail Stop:	
Short Title: Liquid Hydrogen Vent Line Tanking Test Instrumentation Peer Review		
Description: We were asked yesterday (Wednesday May 11) to participate in a peer review of proposed LH2 vent line tanking test instrumentation. This device is a custom-designed pitot tube and temperature probe built into a 1-inch flange that will be installed on the LH2 vent at the interface between the 4-foot flexhose and vent QD. The device is intended to determine, by measuring flow in the 8-inch vent line, whether or not the ET vent valve is leaking under cryo conditions.		
We only had a couple of hours to pull a team together, so we did it on the fly ... Derrick Cheston, Mike Gilbert, and Mike Hagopian provided contacts at their centers with experience in similar instrumentation. The team is composed of Bob Buehrle, GRC, Bryan Fraser, GRC, and William Kilgore, LaRC. An individual at GSFC with extensive cryo experience will be tying in to the team working the LH2 pre-press issue (the genesis of this whole thing). Telecons were held yesterday to discuss the design. Plan is to install the device in the next day or two to support a tanking test Tuesday.		
Source (e.g. email, phone call, posted on web): email		
Type of Request: Real-Time Consultation		
Proposed Need Date:		
Date forwarded to Systems Engineering Office (SEO): (mm/dd/yyyy h:mm am/pm):		
<b>Section 2: Systems Engineering Office Screening</b>		
<b>Section 2.1 Potential ITA/I Identification</b>		
Received by SEO: (mm/dd/yyyy h:mm am/pm): 5/16/2005 12:00 AM		
Potential ITA/I candidate? <input type="checkbox"/> Yes <input type="checkbox"/> No		
Assigned Initial Evaluator (IE):		
Date assigned (mm/dd/yyyy):		
Due date for ITA/I Screening (mm/dd/yyyy):		
<b>Section 2.2 Non-ITA/I Action</b>		
Requires additional NESC action (non-ITA/I)? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		
If yes:		
Description of action: Provide real-time consultation. This has been approved out of board. No initial evaluation is required. Tim Wilson is assigned to lead 5/16/2005		
Actionee: Tim Wilson		
Is follow-up required? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No If yes: Due Date:		
Follow-up status/date:		
If no:		



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NESC Director Concurrence (signature):			
Request closure date: .			
<b>Section 3: Initial Evaluation</b>			
Received by IE: (mm/dd/yyyy h:mm am/pm):			
Screening complete date:			
Valid ITA/I candidate? <input type="checkbox"/> Yes <input type="checkbox"/> No			
Initial Evaluation Report #: NESC-PN-			
Target NRB Review Date:			
<b>Section 4: NRB Review and Disposition of NCE Response Report</b>			
ITA/I Approved: <input type="checkbox"/> Yes <input type="checkbox"/> No		Date Approved: _____	
ITA/I Lead: _____		Phone ( ) - , x	
<b>Section 5: ITA/I Lead Planning, Conduct, and Reporting</b>			
Plan Development Start Date:			
ITA/I Plan # NESC-PL-			
Plan Approval Date:			
ITA/I Start Date	Planned:	Actual:	
ITA/I Completed Date:			
ITA/I Final Report #: NESC-PN-			
ITA/I Briefing Package #: NESC-PN-			
Follow-up Required? <input type="checkbox"/> Yes <input type="checkbox"/> No			
<b>Section 6: Follow-up</b>			
Date Findings Briefed to Customer:			
Follow-up Accepted: <input type="checkbox"/> Yes <input type="checkbox"/> No			
Follow-up Completed Date:			
Follow-up Report #: NESC-RP-			
<b>Section 7: Disposition and Notification</b>			
Notification type: - Select -		Details:	
Date of Notification:			
Final Disposition: - Select -			
Rationale for Disposition:			
Close Out Review Date:			

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### Form Approval and Document Revision History

Approved: _____ NESC Director	_____ Date
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Version	Description of Revision	Office of Primary Responsibility	Effective Date
1.0	Initial Release	Principal Engineers Office	29 Jan 04

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Approved:	Original signature on file _____ NESC Director	10/4/05 _____ Date
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Version	Description of Revision	Office of Primary Responsibility	Effective Date
1.0	Initial Release	NESC Chief Engineer's Office	10/4/05